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ABSTRACT

Science education reform literature is dominated by calls to improve the teaching and learning of science in order to meet the demands of diverse students in a highly technological society. This paper discusses the relationship between teacher beliefs and instructional practices, particularly with regard to science-technology-society (STS) instructional themes. The link between professional development and teacher beliefs is also explored. A model of teacher professional development, the Kansas Collaborative Research Network (KanCRN), is discussed. (Contains 21 references.) (WRM)

Developing Partnerships: Teacher Beliefs and Practices and the STS Classroom

by

Teresa M. Carroll

DEVELOPING PARTNERSHIPS: TEACHER BELIEFS AND PRACTICES AND THE STS CLASSROOM

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Science Reform

Reform of science education and scientific literacy: these issues dominate science education literature today. Our global society demands scientific literacy, which can be achieved through the reform of science education in public schools. The citizenry of the United States must be literate enough to comprehend and make intelligent decisions about everyday issues such as health, water quality, and global warming. Furthermore, the implications of such decisions must be understood. Scientific literacy is the knowledge and understanding of scientific concepts and processes required for making these decisions (National Research Council, [NRC], 1996). National reform efforts have mandated the changes needed in order to create a generation of students that possess a level of scientific literacy significant enough to allow them to take an active part in discussions and decisions about these community and global issues. The reforms of the last 50 years have given educators curriculum materials, teacher proof science kits, and teaching activities. The missing piece, essential for true reform, is the consideration of teacher beliefs and how those beliefs influence teacher practice and student learning (Bybee, 1997).

Science education reform literature is also dominated by calls to improve the teaching and learning of science in order to meet the demands of diverse students in a highly technological society. Successful reform requires input and support from all participants: teachers, parents, college faculty, business mentors, and students. It also requires a long-term commitment of human resources and materials and is made by teachers in the trenches of local schools districts.

These types of reforms are collaborative programs of long-term change (Ellis, 1993). Attempts at change, or reform are often made by training teachers through workshops or conferences with little lasting change. In the review of information about science education reform, teaching and learning, and teacher training, one question became prevalent, however, to this researcher. What type of collaborative effort or professional development would facilitate rather than limit reform efforts in science education?

The purpose of this proposal for study is to investigate a long-term collaborative program termed the Kansas Collaborative Research Network (KanCRN). KanCRN is a science-technology-society (STS) based professional development program of curricular reform in collaborative partnership with the Kansas City, Kansas Public Schools. The intent of this investigation is to develop a study that ties teacher beliefs and practice together with a STS professional development model. An effort will be made to embark on the development of a theory that can be used to interpret types of professional development that would assist in the evolution of teacher beliefs and instructional practices in the science classroom.

Through this paper, the relationship between teacher beliefs as they relate to instructional practices in the classroom will first be addressed. Secondly, a review of the information concerning teacher beliefs in relation to STS themes of instruction is provided. In the third segment, insight into the role professional development plays in the evolution of teacher beliefs and practice is given. In the last section, the KanCRN STS model of professional development, in partnership with the Kansas City, Kansas (KCK) public schools, and how it relates to the concepts of teacher beliefs, practice, and training of teachers will be described. Finally, the proposal for further study is made.

Teacher Beliefs: Impact on Practice

Teacher beliefs play a vital role in the reform of science education. All teachers of science have implicit and explicit beliefs about science, inquiry, teaching, and learning (NRC, 1996). Change in practice can happen only with a corresponding change in the beliefs that govern those practices. Current research on teaching and learning emphasizes a shift in focus from observable teacher behaviors to teacher beliefs and their impact on teacher behaviors and practices. This research differs radically from earlier research that viewed teachers as technicians who delivered pre-packaged curriculum (Isenberg, 1990). Researchers now acknowledge the powerful influence teachers have on curricular implementation, and that often, curriculum is not implemented in the way it was designed to be (Cronin-Jones, 1991). This could be because teachers have difficulty implementing curriculum that does not support their own personal beliefs about teaching and learning. It becomes apparent that teachers' beliefs are at the apex for the choices they make concerning instruction. Teacher beliefs can actually act as a filter through which instructional judgments are made (Shavelson, 1983). These beliefs shape the nature of instructional practice. We must then realize that no matter how pre-packaged the curriculum is, each teacher is an individual with individual beliefs. Consequently, those beliefs will affect the implementation of any curriculum.

In the quest for educational reform, understanding teacher belief systems will contribute to enhancing educational effectiveness (Brophy & Good, 1974). As a result, several researchers are devoting time to understanding the impact of teacher beliefs on practice. Through their work with the Theory of Planned Behavior, Haney, Czerniak, and Lumpe (1996, 1998) determined

that teacher beliefs are "significant" indicators of the behaviors that will be present in the classroom. Given that these behaviors or actions impact students, they play a large role in science reform. Ellis and Maxwell (1995) have shared information concerning the relationship between a teacher's predisposition about implementing various educational innovations and the behaviors and practices that occur. For implementation of the innovation to be successful, teachers must believe that the new innovation is not a "fad". Additionally, they must believe that the innovation will improve teaching and learning, be cost effective, and easy to master. Teachers must be allowed to experiment with the innovation in a low-risk environment and receive positive feedback for using the innovation. From works such as these, the complexity involved in the relationship between teacher belief systems and practices that occur in a classroom can be seen. Hence, reformists and innovators "can only ignore these belief systems at their own peril" (Clark and Peterson, 1986). Reform efforts cannot be top down, quick fix efforts. Further investigations of teacher belief systems in the context of science reform are needed to guide current science reform into lasting change.

Teacher Beliefs about STS

A major movement in the reform of science education is the presence of STS themes of study (Bybee, Ellis, Giese, Parisi, & Singleton, 1992). The STS focus is associated with new goals of science education aimed at the critical thinking, problem solving, and civic decision making capabilities of all students. (Ben-Chaim, Joffee, & Zoller, 1994). With STS themes of study, students work at self-directed rates with several activities going on in the classroom concurrently. The teacher facilitates and coordinates the learning tasks, and students become

active participants, working at higher levels of thinking. (Loucks-Horsley, Kapitan, Carlson, Keurbis, Clark, Melle, Sachse, & Walton, 1990). STS implementation practices open paths to instructional strategies that engage students in long-term, inquiry, discovery, or research-based approaches to learning with real world applications.

Teacher beliefs play a major role in classroom reform. Teacher participation in reform is critical. Thus, when considering a STS approach to classroom instruction, teacher beliefs about STS implementation require attention. Teacher beliefs concerning STS implementation and inquiry learning can defeat the reform movements emphasizing STS themes. In fact, a problem noted in the work of Ben-Chaim et al. (1994) was that teachers had trouble distinguishing between science technology tools and general technology. This indicated that teachers must be involved in the actual development of STS curriculum so they can build their knowledge concerning STS themes of teaching and learning and reform their beliefs along the way. As students are constructing their own knowledge about STS themes of study, teachers must also have the opportunity to construct their views and beliefs about STS. For STS directed change to be successfully institutionalized teachers must be empowered as researchers and participants in the decision making process (Ben-Chaim et al., 1994). Beliefs built through participation and active research of teachers will translate into whether or not they effectively implement a STS program of study.

Beliefs about the inclusion of STS study should first be identified so training can focus on the identified beliefs. When asking teachers open-ended questions about STS instruction, Lumpe et al. (1998) found that teachers believe including STS can develop decision making skills in students and provide meaningful applications of science to real life. However, their concern

lies in the time it takes to do this type of teaching and learning, as well as the controversial issues that are involved in some STS themes. Identifying these concerns is important because they form the beliefs teachers hold toward STS themes of study, and the practices that occur in the classroom. However, addressing these concerns takes time. The NRC (1996) tells us that teachers can be effective guides for student learning if they have time to examine their own beliefs. Therefore, identifying beliefs is the first step in fostering true change.

Beliefs about STS instruction can be reformed by means of appropriately designed inservice training consisting of intensive training in the areas of scientific knowledge and inquiry skills (Ben-Chaim et al., 1994). This type of professional development however, cannot take the form of an after-school inservice meeting. Teachers need time to reflect and reshape their beliefs. This period of time is stressful for teachers. However, as stated by Dwyer, Ringstaff, and Sandholtz (1991), "teacher beliefs may best be modified while they are in the thick of change, taking risks, and facing uncertainty" (p. 46). So while this might be overwhelming, positive beliefs about STS can be fostered. Moreover, long-term professional development gives teachers the time and opportunity to correlate their beliefs with reform recommendations.

Beliefs, Practice, Change, & the Role of Professional Development

What is meant by long-term professional development? Previously, professional development consisted of one-hour, after school inservice meetings, or two daylong conferences. Additionally, teachers have not been seen as sources of information on what is needed in their professional development. As Liberman (1995) reported, "teachers have been told all too often that other peoples' understandings of teaching and learning are more important than theirs and

that their work with students everyday is of less value" (p. 67). Traditional approaches to teacher development are limited because they lack knowledge of how teachers learn, ignore teachers' voices, and revolve around the belief that teaching is a technical set of skills void of teacher invention or the crafting of knowledge. Additionally, traditional professional development has often ignored the context within which teachers work (Liberman, 1995). School administrators are beginning to discover the power and critical importance of professional development when it is viewed as an integral part of life in a school.

Professional development in contemporary education is evolving into a model consistent with the way teachers are expected to work with their students. That model consists of knowledge building, or the constructivist approach to the development of knowledge and techniques, verses information dissemination (Liberman, 1995). People learn best when they are actively involved in thinking about and discussing what they have learned. Contemporary professional development is seen as an active, ongoing, lifetime process that occurs in the daily context of classroom practice. Professional development practices that are built on this approach are at the heart of an expanded view of teacher development. Furthermore, Liberman (1995) found that professional development practices of this type allow teachers a voice in dictating the direction of their professional learning and allow for the construction of ways to bridge the gaps between theory and practice. Teachers get more from their professional development activities because they help determine them.

Included in the new conceptions of professional development is the idea that teachers must participate in a form of daily inquiry about their profession. This type of action-based research should be seen as part of the expectations for the role of a teacher. If teachers want their

voice to be heard, they must be willing to be involved with rigorous, daily research about the teaching and learning that happens in their classrooms. Teacher learning does not end with preservice training. Professional development for teachers should be as rigorous as the professional development for other professions. It should be a lifelong process that is an integral part of the culture of the school day (NRC, 1996). Teachers are involved in continuous decision making about the actions that will facilitate student learning. Skills in making these decisions are developed by active participation in the development of knowledge and reflection concerning effective techniques of practice. Professional development activities must also be sustained, contextual and require participation and reflection (NRC, 1996).

If reform plans are to be made operational, enabling teachers to change the way they work, teachers must have opportunities to talk, think, try, and hone new practices. This means they must be involved in learning about, developing and using new ideas with their students (Liberman, 1995). Teachers must be allowed to be the sources of their own growth and professional development. As professional development moves from a traditional inservice model toward long-term continuous learning, the idea of professional development takes on new meaning and status. Involved in that new meaning is the idea of collaborations between teachers, parents, universities, business mentors, and schools.

A Partnership: The Kansas Collaborative Research Network

Although there is a vast amount of professional development that takes place inside the school, there are a growing number of partnerships that exist with schools that offer opportunities for teachers to work on topics they develop, or that are of interest to them.

Benefits of such partnerships are the development of a community of shared understandings that support change in teaching practices and provide the intellectual stimulation necessary for lasting growth and reform (Liberman, 1995).

One such partnership is the Kansas Collaborative Research Network (KanCRN). KanCRN is a community of researchers, teachers, and students interested in conducting collaborative research. The U.S. Department of Education funds KanCRN under a technology innovation challenge grant. Developed originally by the Kansas City, Kansas Public Schools, the Olathe, Kansas School District, and the University of Kansas, this cohort is working together to create a professional development model that demonstrates that doing science is a better way of learning science. The new Kansas State science standards are clear about the central importance of real science. The partnership has grown to include the Kansas City, Kansas Public Schools, the Turner School District, the City of Kansas City, Kansas, the County of Wyandotte in Kansas, the Catholic Archdiocese of Kansas City, Kansas, Environmental Systems Research Institute Inc., High Performance Systems Inc., Genentech Corporation, the Kansas Data Access Center at the Kansas Geological Survey, Silicon Prairie Technology Association, and the Advanced Learning Technology Alliance at the University of Kansas. Consortium partners such as the University of Kansas, Silicon Prairie Technology Association, and Science Pioneers provide the "mentor connection" arm of the partnership. These groups have joined forces in an effort to develop a community of researchers, mentors, teachers, community persons, parents, and students interested in conducting collaborative research into the nature of the natural, social, and economic world. As Ellis (1995) states, with the stakeholders as the creators of the projects, relationships are developed around naturally occurring commonalties and interests and not with a

"top down," "teacher proof" approach. The community of KanCRN seeks to expand to nationwide participation and is committed to promoting the processes of scientific research among students.

Following is a description of the KanCRN Professional Development Model, Student Involvement with the Model, the Role Technology plays in the partnership, the Societal Link present in the model, and KanCRN's consideration of Teacher Beliefs. Baseline Data Collection will then be shared, and finally, proposal for study will be made.

<u>The Professional Development Model of KanCRN</u>

As stated previously, teacher voice and active involvement in knowledge building within their own professional development is essential in order to bridge the gaps between beliefs, theory, and practice. Educational change has a greater chance to be successful in programs where all stakeholders work collaboratively and voluntarily to establish and embrace common goals and courses of action (Woodrow, Mayer-Smith, & Pedretti, 1996). Additionally, when implementing programs of change, there must be multiple training sessions over extended periods of time by credible and knowledgeable instructors. Training activities must be matched to the concerns and needs of the teachers, and teachers must be involved in the planning of the program. Implementation should occur with an appropriate balance between training and practice in a comfortable, low-risk environment. (Ellis, 1995).

The KanCRN model exists in an environment where teachers and business mentors jointly create the learning experiences and develop courses of action to improve the teaching and learning of science. KanCRN selects teachers who sign on with the collaboration to develop new

projects. Furthermore, minigrants are offered to teachers who have collaborative ideas they are interested in developing. Teachers are active participants in the decision-making processes of the program, because they are learning by doing. Additionally, their professional development occurs through active participation in the context of their classrooms where the improvements in their teaching lend themselves to greater opportunities to improve student learning. This opportunity to experiment and work with new curriculum in the low-risk environment of their classrooms is seen as a precursor to the effective implementation of innovative curriculum. Not only are the STS curricular projects of KanCRN developed by teachers, but the teachers also govern the multiple types of professional development activities that are offered by the qualified KanCRN developers, mentors, and teachers. The suggestions for professional development needs come from interviews, surveys, and discussions with teachers. Through their active participation in the development, implementation, and collaborative meetings with the KanCRN developers and mentors, teachers have the interaction, voice, and time needed to correlate their beliefs and practices with reform recommendations.

There are various additional types of support available for teachers involved in the KanCRN projects. On-line support for teachers includes descriptions of development opportunities that teachers have requested along with a calendar of the times they are offered. A teacher chat room for sharing ideas and questions, a list serve, and many links to outside resources are also available on-line. Teachers involved with the KanCRN partnership meet together after school three days a week to monitor and assess the effectiveness of the program. They also meet with the developers one time a month and for five days during the summer to evaluate the program and plan new projects. Teachers are paid for their professional

development time. Opportunities to attend presentations and classes developed around topics requested by the teachers ensure that their needs are matched with development opportunities. This active participation also gives teachers needed ownership in their professional development.

Student Involvement

Noteworthy instructional models for science and technology learning need to be consistent with the way scientific investigations are carried out. Students working on KanCRN projects collect and analyze data. They then develop a social action plan based on the data. The hope is that this discovery-oriented approach to knowledge acquisition will develop students who take an active role in their learning, assume more responsibility for the direction of their work, and become literate decision-makers.

The basic activities of KanCRN include structured research projects located on the KanCRN web site. The web sites are fully interactive, allowing students to communicate with other students working on the same or similar projects. These posted research ideas include background information on specific themes, protocols for conducting experiments, data submission forms, databases linked to the web site for storing collected data, display of school data, and form-based web pages for submitting personal research work. Teachers, students and research mentors communicate about research projects using the discussion forums also located on the KanCRN web site. The web site also serves as a repository of student work, submitted on-line and made available for evaluation, scoring, publication, and dissemination. Students use the structured research projects as a sounding board for their own research. Mentors provide feedback to students and teachers about the research questions they generate, about their experimental investigative procedures, and about the data they collect. Additionally, mentors

provide helpful and suggestive feedback about the conclusions they reach. A student research conference is held annually at the end of the academic year for students to present the results of their research in a "professional conference" atmosphere.

Table 1
Sampling of KanCRN Projects

1. Ground Level Ozone—ground level ozone is believed to be the most ubiquitous air pollutant and the cause of most of the injury to biological resources. Using a combination of ground level testing and a bio indicator, students will determine the extent and impact of ozone on local ecosystems. (Elementary-high school grade levels).

2. SO2 and Lichens—research indicates that lichens and the tardigrades living on them can be used to access atmospheric levels of SO2. When lichens are exposed to some kinds of air pollutants, especially to sulfur dioxide, lichens are injured and die. They therefore make good indicators of air pollution. The effect of these pollutants may be observed on the distribution and diversity of a simple community living on the lichens. (High school grade levels).

3. UV and Yeast—human activities, including the production of chlorofluorocarbons, have reduced the concentration of stratospheric ozone. Ozone molecules in the stratosphere filter biologically harmful ultraviolet radiation (UV-B) coming from the sun. A possible biological UV dosimeter is an ultraviolet sensitive strain of yeast. Students use this indicator to gain a deeper understanding of this global change. (High school grade levels).

4. Amphibian Biomonitoring—because amphibians have a biphasic life cycle, permeable skin, and are exposed to pollutants and other environmental stresses on a daily basis, they can serve as an early warning indicator of potential drastic changes in the ecosystems. Students investigate the worldwide decline in amphibian population as a possible indication of declining environmental conditions. (Middle-school grade levels).

5. Natural Dyes and Stain Removal—this projects invites students to participate in using the scientific research methods to explore introductory biochemistry. Using local plant species, the students will hypothesize about the colors that will be generated. Questions to be investigated include: Are natural dyes more environmentally friendly than synthetic dyes? Do natural dyes resist stains? Do the natural dyes hold their color? (Elementary and middle school grade levels).

The Role of Technology

KanCRN uses technology as a tool to allow students the ability to do things they would not otherwise be able to do. Students use technology as the avenue to work within the projects, for information gathering, communication, data collection, data sharing, data analysis, and publication of work for review. Teachers use technology in many of the same ways. Technology, however, is much more than hardware. Technology originates in problems of human adaptation to the environment. From the problems identified in adapting to the environment, solutions to problems are developed. Through interaction with KanCRN projects, science is linked to technology in order to facilitate problem solving and meaningful learning. The hope is that students will be prepared to understand the implications of both science and technology in their own lives.

The Societal Link

The integration of technology underlies KanCRN. Technology is used to allow students the ability to do things they would not otherwise be able to do. KanCRN is a local collaborative research model that uses technology to incorporate the fundamental vision of the national standards of both science and math, and the benchmarks in science. The project includes elements of communication, data collection, data sharing, data analysis, and publication of work for review.

The KanCRN model contains a clear link to the social sciences. The science problem solving cycle and a cycle of societal ethical decision making drive one another. This link provides a pathway for students to follow as they use the knowledge they have helped generate to begin

effective social action. The model posits student movement from just being activists to becoming decision-makers who base their actions on knowledge.

While the focus of this project is science and math education with a link to the social sciences, the tools of KanCRN are flexible enough to be used by any curriculum area that incorporates inquiry, research, and/or modeling as a part of their curriculum. It is anticipated that teachers across a broad spectrum of disciplines will be interested in applying KanCRN tools to their curricula. Because of the nature of student work in KanCRN that includes emphasis on reading, writing, and oral presentations, it is anticipated that technology will also support the goals of communications and language arts programs.

The goal is to create a scientifically and technology literate population of students that will create and act on knowledge and make educated decisions on the personal, ethical, and societal questions raised by their interaction with, and dependence, on the natural world.

KanCRN's Connection to the National Science Standards

The project proposes a new relationship between research and education. This type of daily inquiry is essential for teachers in their building of knowledge and consequent change in practice. Additionally, the result of this type of inquiry research aids student learning and adds significance to student understanding of the natural world. Inquiry is central to science learning. Students involved in inquiry ask questions, make predictions and inferences, and work toward solutions. Through scientific inquiry the students' questions can be derived from curiosity about everyday life. As individual students share their findings with others, they evolve into scientific communities (NRC, 1996). Good school science, as Loucks-Horsley et al. (1990) tell us, engages children in the study of the natural world. The desired outcome is for children to be good

explorers. We also want them to pose good question, make predictions, and construct their own knowledge about scientific principles along the way. This is the ultimate vision of KanCRN: doing science.

From this perspective, it can be seen that KanCRN addresses the vision of the National Science Standards by modeling the research process and by providing for student reading and writing applications. In the vision presented by the Standards, inquiry is a step beyond "science as a process," in which students learn skills such as observation, inference, and experimentation. The new vision includes the processes of science and requires that students combine processes and scientific knowledge as they use scientific reasoning and critical thinking to develop their understanding of science. Combining the conceptual with the procedural unifies the science disciplines and provides students with powerful ideas to help them understand the natural world. Science as inquiry is basic to science education and is a controlling principle in the organization and selection of student activities. Engaging students in inquiry provides them with opportunities to develop an understanding of the nature of science. Science should not be something that is done to the students, but by them. KanCRN also ties with the National Science Standards in the area of professional development. Those ties are in the process of being defined.

The KanCRN model of professional development involves teachers in long-term professional development in the context in which they work, the classroom. It is an integral part of the school day. Teachers and students are both involved in "doing" science. Teachers, as the developers, researchers, and participants with students in inquiry, are the source of their own

growth and professional development. This is essential in order to achieve true reform of teacher practices.

KanCRN and Teacher Beliefs

The successful implementation of an innovative curricular program in the classroom is dependent upon the full participation and shared vision of the teachers involved in the decision making process. This shared vision cannot be achieved without attending to the beliefs of the teachers involved. Teachers fall along a continuum from those who teach using demonstration laboratory exercises, to those who involve their students in original research. The decision of a teacher's place on the continuum is based on their beliefs. The relationship between teachers' written statements of beliefs are inconsistent with practices. Liberman's (1995) work with the Southern Maine Partnership supports this inconsistency theory. This nine year partnership between the University of Southern Maine and a group of surrounding school districts brought teachers together to discuss research and educational practices. It became apparent that what they believed and valued and what they practiced were not always in synch. The result of the partnership has been a reform in the teacher education programs in both the university and the public school. This bringing together of teachers and university faculty provided both with access to new ideas and a supportive community aimed at reform of teaching and learning. Members of the KanCRN partnership hope to achieve this type of result with the implementation of its STS model of professional development.

In an effort to achieve more congruence between the intended and implemented curriculum, professional development should put more effort into determining teacher beliefs by soliciting input from teachers during all phases of the program implementation. Several studies

have focused on teacher beliefs involved in innovative programs and the implications for practice. Haney et al. (1996) worked extensively with the Theory of Planned Behavior Model. With this model, beliefs were used to predict individual intention to engage in specific behaviors. Through their work, they discovered that teacher attitudes and beliefs were critical to change in practice. They reported that attendance to beliefs is a precursor to change. In their latest work, Lumpe et al. (1998), involve teacher beliefs and STS themes of instruction. They reported that teachers believed that including STS in classroom practices could develop decision-making skills, enhance science learning, and provide meaningful applications of science to real life. However, they were concerned with the time it takes to teach STS, staff development issues, and needed resources and support. Moreover, they stated that fostering positive beliefs and attitudes about STS may involve providing teachers with concrete and positive experiences with actual STS issues as well as involvement with real scientific investigations of STS issues where opportunities exist for teachers to operationally define STS. This would suggest that change in beliefs could be an interactive process, and change in practice might be the end result.

This is the structure of the KanCRN STS model of professional development. Through KanCRN teachers are provided opportunities to facilitate and participate in scientific investigations of STS issues which will allow them to operationally define STS. When teachers are given the opportunity to correlate their beliefs with those of the innovative program, true reform will occur. Teachers must actively engage in dialogue and reflection about the inclusion of STS (Lumpe et al., 1998). KanCRN provides these opportunities through active teacher participation in the development and monitoring of the program. As the NRC (1996) confirms, when teachers have the time and opportunity to describe their own views about teaching and

learning, conduct research on their own teaching, compare and revise their views, they will come to understand the nature of exemplary science teaching.

STS is a theme in science education reform that can empower teachers to change their practices in the classroom. Beliefs about the inclusion of STS must be identified so the professional development activities can target those identified beliefs that appear to influence teacher practices and actions. The intention is that once beliefs are identified and targeted, a fostering of positive beliefs about teaching STS can occur. To this end, KanCRN's evaluation activities in the months of initiation focused on the development of a survey instrument for baseline data collection. Survey questions included information concerning teacher beliefs and practices, teacher utilization of inquiry-based learning opportunities, and instructional uses of technology.

Baseline Data Collection

For the purpose of this investigation, a subset of questions dealing with STS issues were extracted from the survey instrument and reviewed in order to measure information on teacher beliefs concerning teaching and learning and the practices that occur in the classroom. For the purpose of clarity, the questions selected dealt with STS beliefs and practices that are qualified as follows:

1. Long-term, inquiry, discovery or research-based approaches.
2. Self-directed learning.
3. Class work emphasizing authentic work for audiences outside the school.
4. Class work and assignments including real world societal applications.
5. Technology used as a tool to gather and analyze data or information.

6. Technology used as a tool for research.

With more than 1000 teachers responding to the survey, initial findings support the incongruency theory Liberman (1995) found in the Southern Maine Partnership. Data based on a five point Likert Scale indicate that 74.8% of teachers considered long term, inquiry, discovery, or research based approaches to learning desirable. However, only 27% of respondents stated that these practices occur often or very often in their classrooms. Secondly, 52% of teachers believed that student self-directed learning is beneficial. Nonetheless, 74% reported that students working on the same assignments at the same time were the most frequently occurring practice in their classrooms. Teachers also reported that they believed that student class work should include rich and lengthy applications to real-world situations. While 64% stated that they agreed or strongly agreed with this, only 42% stated that these practices occur often or very often in their classrooms. The survey also showed that only 9% of teachers have encouraged students in their classes to use a computer as a tool for research or as a means to gather or analyze data. Finally, 46.3% of teachers responding believed that class work should emphasize authentic work for an audience outside the classroom or school. However, only 21% stated that these practices occurred in their classrooms.

Proposed Study

Successful change does not occur without perseverance. All constituents, teachers, students, planners, developers, and support people must have time to share ideas and beliefs and draw conclusions. For any innovation to become an integral part of a school's instructional program, the school personnel must go through a cycle of change characterized by the stages of initiation, implementation, and institutionalization (Ellis and Maxwell, 1995). Initiation refers to

the time when schools are becoming familiar with the feature of the innovation. Pilot tests are being performed, and decisions about adoption are being made. Implementation refers to the stage where teachers begin to use the new program. This stage requires at least three to five years. During this time it is essential that activities for training, consultation, support, and monitoring the program's implementation be put in place. During the institutionalization stage, members of the leadership team must consider how they will ensure that the changes are widespread and are self-sustaining. KanCRN is just beginning its second year and is in the early implementation stage.

From the initial analysis of the baseline data, teacher beliefs, while encouraging, are not consistent with their practice. In further study, the intent is to use this baseline data as a measure of the status of the relationship between teacher beliefs concerning STS instruction and the practices that occur in the classroom. The baseline measure will be used as a comparative measure to assess the effectiveness of the implementation of the KanCRN STS model of professional development. The purpose is to determine if providing teachers concrete experiences with STS issues, which involve scientific investigations, will foster changes that will bring consistency between their beliefs and their practices in the science classroom. Further evaluation processes might include data collection methodologies comprised of videotapes, observations, and interviews of teachers. It is important to discover the reasons for these inconsistencies and find ways to assist teachers in improving and stimulating an inquiry-based instructional environment.

Final Reflections

Providing support structures such as resources, staff development, and inclusion of STS issues in local curriculum may help teachers develop a more positive sense of control for teaching STS (Lumpe et al. 1998). Collaborative partnerships such as KanCRN can provide these tools. These subject-specific teacher collaboratives are growing in number. They open up a new definition of professional development that encompasses teacher knowledge of student learning and instruction. In addition, teachers have access to a broader network of professional relationships. Teachers become partners in producing and leading the reform of their profession instead of consumers.

The changes occurring in science education create conflict with the fundamental teaching beliefs of many teachers. Despite the overwhelming push toward teaching methods involving research and inquiry, there is little evidence that these practices are happening. Successful reform requires input and support from all participants: teacher, parents, college faculty, business, and students. True reform also requires a long-term commitment of human resources and materials. KanCRN possesses these qualities. Hopefully, an outcome of this investigation will be a contribution to the understanding of the relationship between teacher beliefs and practices in the science classroom and the types of professional development that would assist in the evolution and correlation of these beliefs and practices with reform recommendations.

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